WHICH ARIZONA RESIDENTS SHOULD RECEIVE PREVENTION PROGRAMS TO REDUCE MOTOR VEHICLE CRASH INJURIES?

-- Discussion Paper for the Injury Prevention and Control Project, Motor Vehicle Crash Committee --

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INTRODUCTION

The Arizona Department of Health Services has set a high priority on addressing the leading causes of injury. One of the leading causes of injury is the category called "motor vehicle crashes" (MVC's). They account for a significant number of the deaths and hospitalizations of Arizona residents.

The following report presents the count and rate of hospital admission of persons injured in motor vehicle crashes. We rank the zipcodes of the home residence of these injured persons in the hope that intervention efforts can be directed toward the higher risk areas.

BACKGROUND

Arizona has a major problem with injuries caused by motor vehicle crashes (MVC's). Deaths from motor vehicle-related injuries account for approximately half of all unintentional deaths in Arizona: in 1999 there were 980 deaths from motor vehicles, and 1159 from all other causes of unintentional deaths combined.[1] Death from MVC's is the largest single category of injury death, followed by suicide (773 deaths), homicide (457 deaths), and falls (404 deaths). Furthermore, for at least the past 15 years the Arizona rate of death from motor vehicle-related crashes has regularly exceeded the rate of the United States.[2,3]

National data show that simply looking at deaths from MVC's under-represents the problem because a crash will cause an injury and hospitalization more often than it causes death. A more representative approach includes persons who are hospitalized; the discharge status of the hospitalized person may be "dead", or it may be "alive."

In this report we analyze hospital data to identify high risk areas according to the injured person's residential zipcode. We address the question: "Which areas in Arizona have elevated rates of hospitalization due to MVC's?"

METHODS

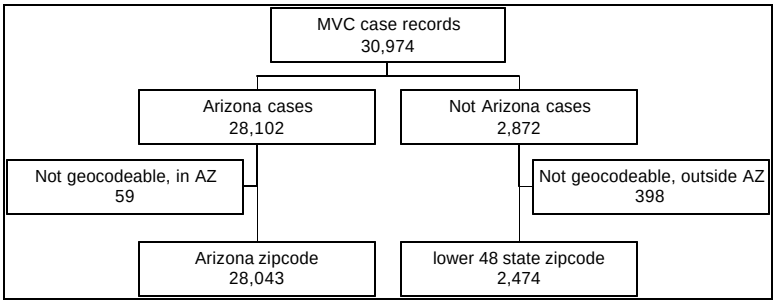
We accessed files of the Arizona Hospital Discharge Database (HDDB) for hospital discharges occurring between 1995 and 1999. The year 1999 was chosen because it is the latest year for which data are available. We looked back 5 years (to 1995) to obtain counts large enough to assess the rates in relatively small areas, specifically, the zip code areas. Then we filtered for records that met the following criteria:

1. We included discharges where the admit type was "emergency" or "urgent". That is to say, we did not include hospitalizations that were on an elective basis or were for "observation."
2. We included discharges for which an External Cause code (E-code) was listed between E810 and E819, inclusive.[4] These are the specific E-codes that indicate an MVC. The HDDB has two specific fields for entry of E-codes. We included records if either of the two E-code fields or any of 9 diagnoses fields contained an E-code in this range.
3. We excluded discharges with a principal diagnosis that contained a V-code.
4. We excluded discharges for rehabilitation (DRG code 462) or admissions where the patient was transferred in from a skilled nursing facility.

To perform the geographic aspect of the project, we accessed the ESRI ArcView map of the 404 zipcode areas in Arizona. After we merged zipcodes that appeared to be post office boxes or "islands" within larger zipcode areas, there were 303 remaining zipcodes in Arizona (see **Map 1** and Appendix Table 1). From our previous work on this topic we know that the mortality rate from MVC is elevated among the Native American population. So, we overlaid the boundaries of Indian Reservations for purposes of orientation on subsequent maps that we generated for this project (see **Map 2**).

A flow chart of records is shown in Figure 1. During the 5-year period, 1995-1999, there were 30,974 records of persons admitted (discharged*) with an "MVC" code as the cause of hospitalization. Of these records, we determined that 28,102 contained Arizona addresses, of which 28,043 were geocoded within Arizona and 59 could not be geocoded. Of the 2,872 records that did not indicate an Arizona address, we geocoded 2,474 into a zipcode in the lower 48 states (other than Arizona); 398 records could not be geocoded into the lower 48 states because they were from out-of-country, Hawaii, Alaska, or had no address at all.

Figure 1. Outcome of the geocoding of records from the Arizona Hospital Discharge Data Base. The cases were discharged during the period 1995-1999.



We then submitted the patient records with Arizona addresses and zipcodes to the address geocoding feature of ArcView, which assigned a latitude and longitude to the patient's address. We were interested in producing geocodes that were accurate at the zipcode level. We ordered the records by the count of admissions and produced a map

* We use the terms hospital "admission" and "discharge" interchangeably in this report.

of the zipcodes ranked by quantile of the number of admissions (see **Map 3**). Next, we used the ArcView software to supply the population figures for each zipcode during 1997 (the midpoint year between 1995 - 1999), and we multiplied by 5 years to obtain the number of person-years at risk. These figures were the denominators. We divided the counts of injured persons by the population-at-risk within each zipcode and multiplied by 10,000 to produce an annualized, crude rate per ten thousand population. We then ranked the file of zipcodes in order by their MVC rate, and produced quantiles of the 303 Arizona zipcodes (**Map 4**). In order to avoid presenting areas whose admission rates could fluctuate too radically because of small numerators, on the final map we shaded out ("suppressed") the zipcodes with fewer than 25 occurrences during the time period. Of the 303 areas, 109 had fewer than 25 incidents during the 5-year period. This left 194 zipcodes with 25 or more admissions for MVC. These zipcodes, ranked by MVC rate, are shown in **Map 5** Similarly, we assessed the hospitalization rates for the Phoenix metropolitan area, as shown in **Map 6**.

As a separate step, we generated a frequency count of MVC admissions by state. This was performed to measure the load of cases whose residence is outside of Arizona. We ranked the states by quantile of the number of hospital discharges and produced a U.S. map of this ranking (see **Map 7**).

RESULTS

Areas on Maps 5 and 6 with solid dark shade represent the quantile with the worst (highest) hospitalization rate; the stippled dark areas represent the zip codes with the second worse hospitalization rates. Areas with lighter stippling have the best (lowest) hospitalization rates.

The hospitalization rate among the 303 zipcodes ranges from 0 to 1666.67 hospital discharges per 10,000 residents. Then, after suppressing the 109 zipcodes with fewer than 25 discharges, there are 194 zipcodes in the final map of hospitalization rates (**Map 5**). The zipcodes that remain after the suppression are scattered across the state. However, we note two areas that we wish to highlight: the high rate among Prescott area residents appeared to stretch across several zipcodes, and high hospitalization rates across a large, contiguous, Phoenix area south of Thomas Road.

The hospitalization rates in rural zipcodes show some areas with high rates, but there is no unifying pattern or theme that we could identify with regard to the rural areas or reservations.

The number of persons hospitalized in Arizona but residing in other states shows that our neighboring states contribute the most cases. However, we also see a significant number of hospitalizations from the residents of Texas, Washington, and the Midwest states.

DISCUSSION

We note a grouping of residential zip codes with high rates in the Prescott area, and high rates in all of south Phoenix. However, there is no such clear, obvious, or consistent pattern that we could identify with regard to the residence in other rural areas or Indian reservations. Nevertheless, some rural areas including reservation lands were among those categorized in the highest quantile.

There are a number of limitations of this approach. 1) It assumed consistent E-coding of hospital data across the state; however, we do not know how consistent the E-coding has been. 2) We did not include hospitalization data from the Indian Health Service; if we were to include it, the rates in some rural areas or reservations may increase. 3) Crashes in which there was a fatality prior to arriving at the hospital were not counted; this may under-represent crash rates in rural areas because the longer transportation times that occur there may be associated with higher fatality rates. That is to say, a person dying at the scene or during transportation is not counted as a hospital admission.

Zipcodes are difficult to use in population-based analysis because they are not census-type units. That is to say, the estimate of the number of inhabitants within zipcodes is imprecise and less accurate than using census tracts.

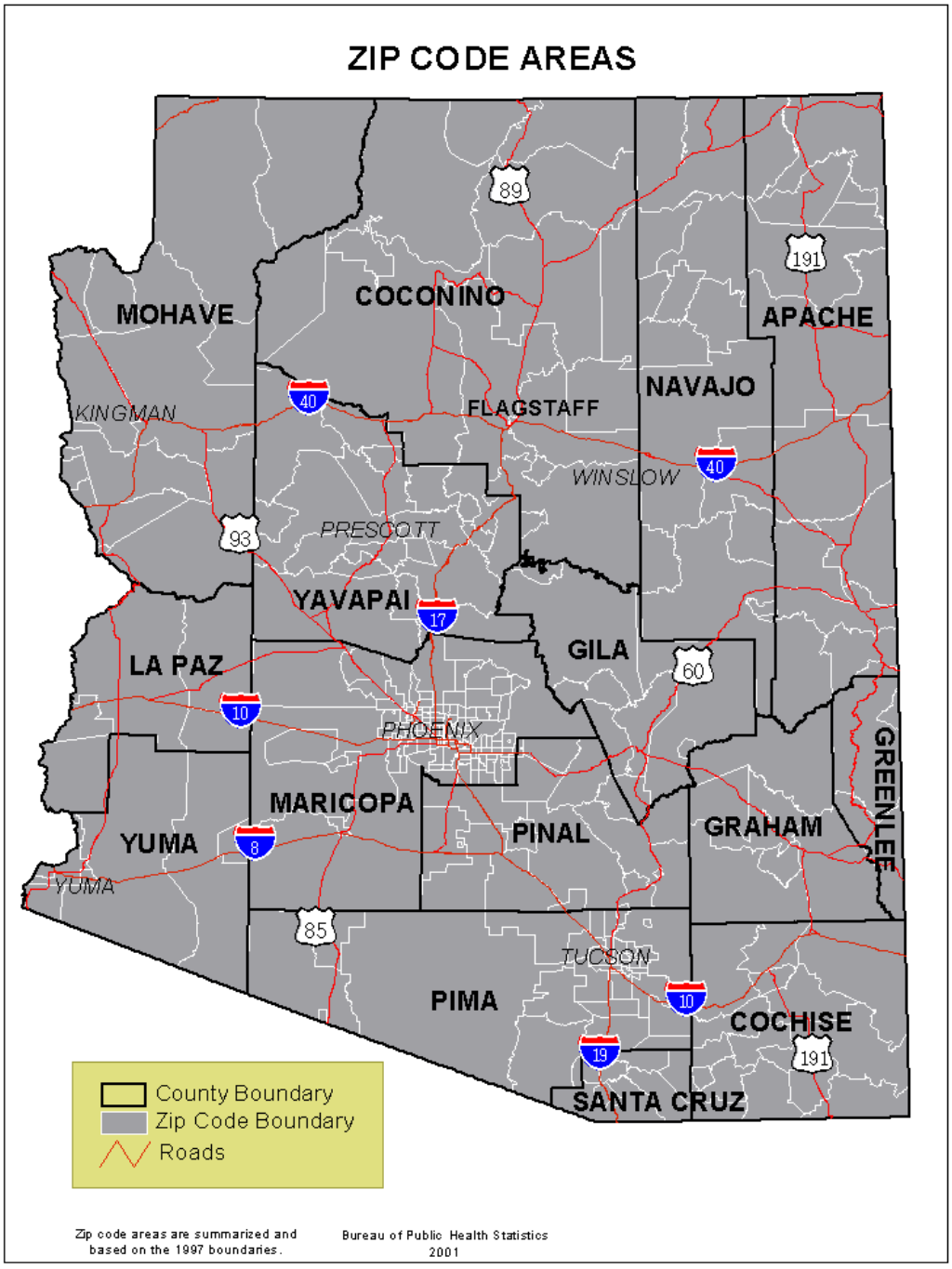
A strength of this approach is that it uses geographic areas (zipcodes) that are easily understood by the public and policy makers. Our overlay of legislative districts in the Phoenix area also can be useful for policy level decisions.

Because we required 25 or more cases to display a zipcode area in Maps 5 and 6, we can be fairly confident in saying these areas deserve efforts to reduce hospitalization rates. It would be helpful to know more details of the crashes that have affected the residents of those areas in order to know which type of intervention to apply. For example, the message may need to be customized to increase seat belt use, promote use of child restraints, discourage driving under the influence of alcohol, or to address other modifiable causes. Age-specific interventions that address problems specific to older drivers or teenage drivers also may be appropriate.

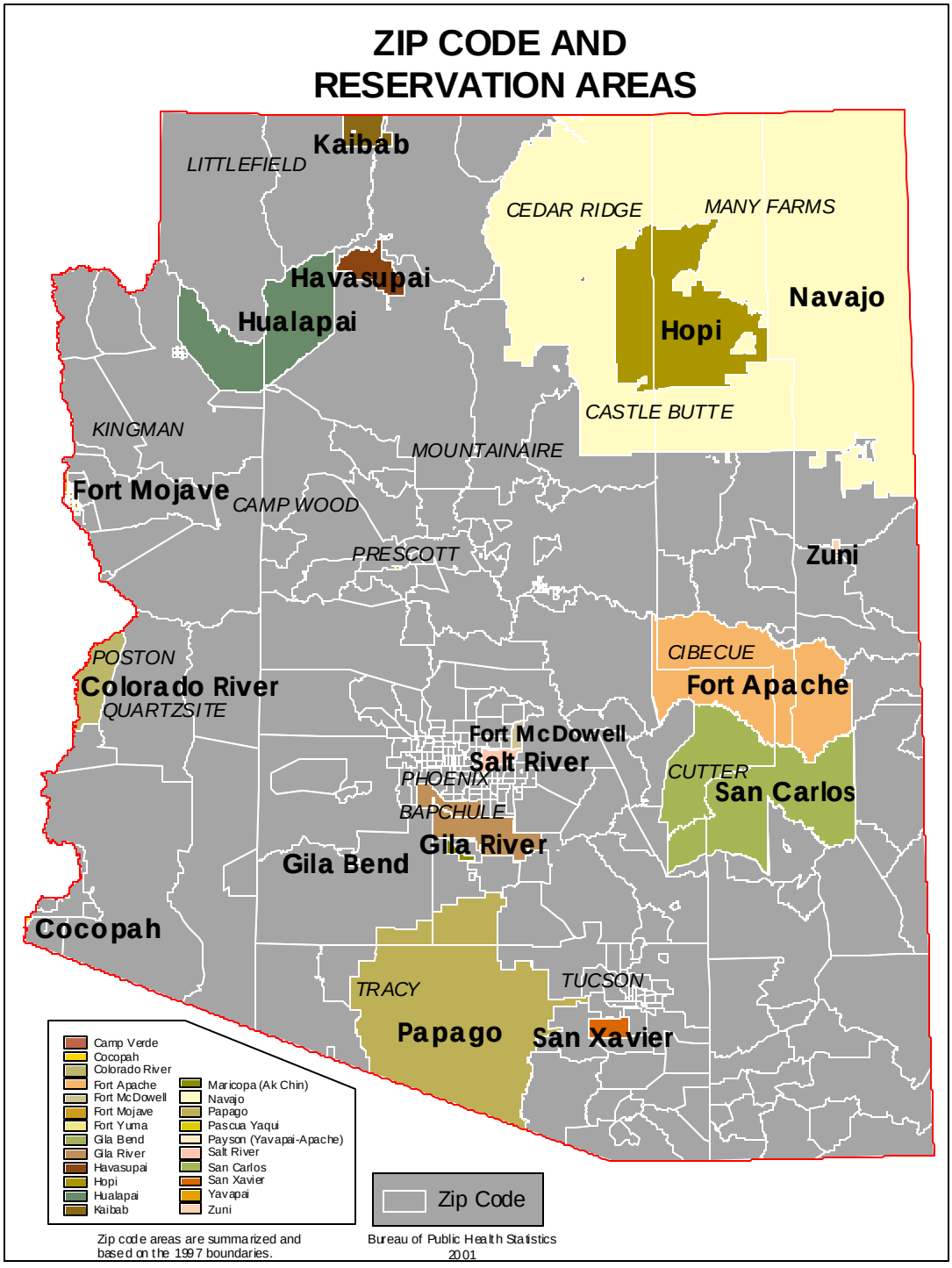
CONCLUSION

These maps can help public health officials to target prevention programs aimed at residents within specific, high rate areas. We would suggest starting with residents in the Prescott area and in south Phoenix. Public health workers from rural areas and Reservations can review these maps to determine their relevance to their local situations.

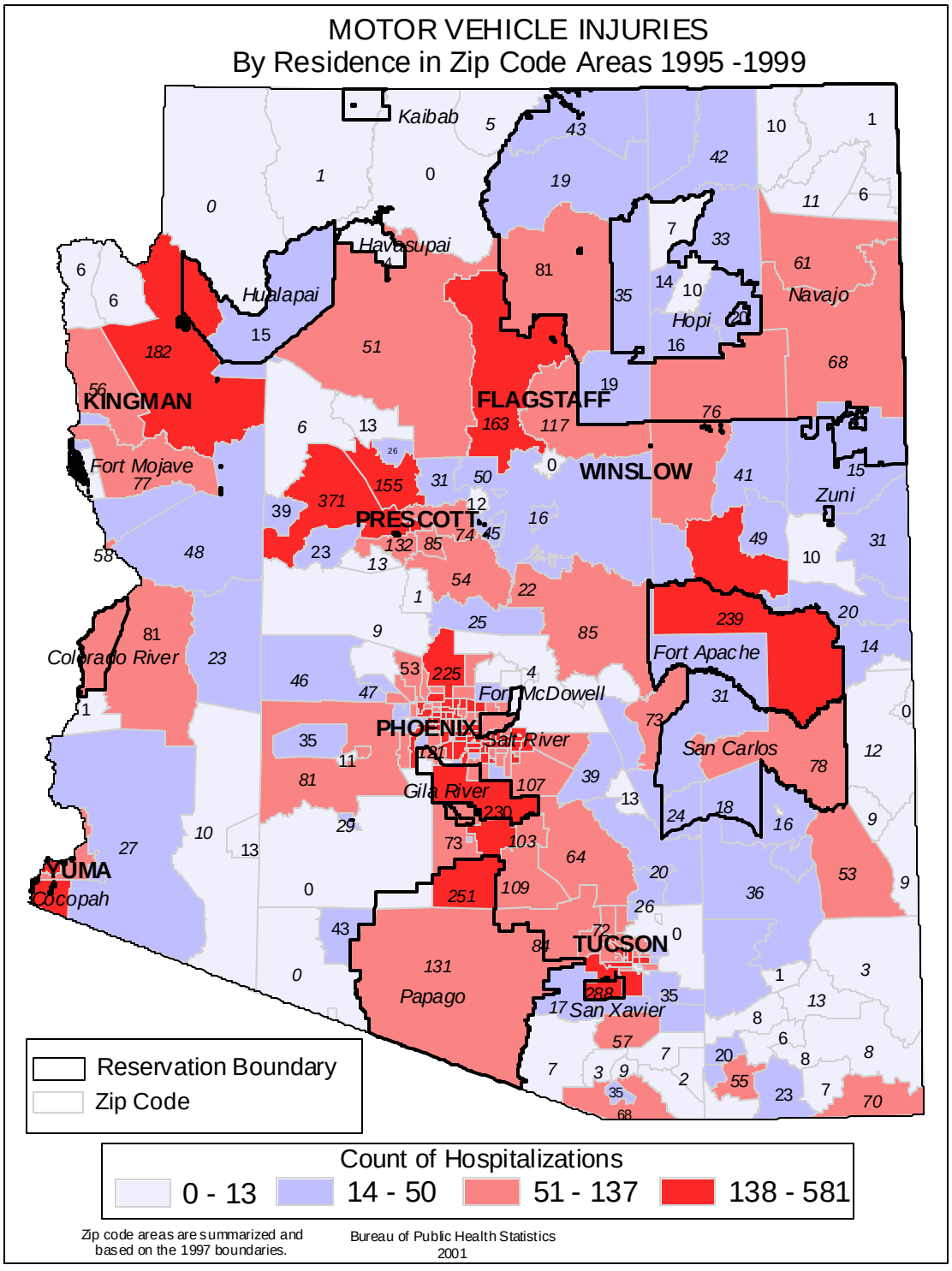
Map 1. Location of 303 zip codes in Arizona after merging the post office boxes and other small areas. County and city names are shown to orient the reader to the map.



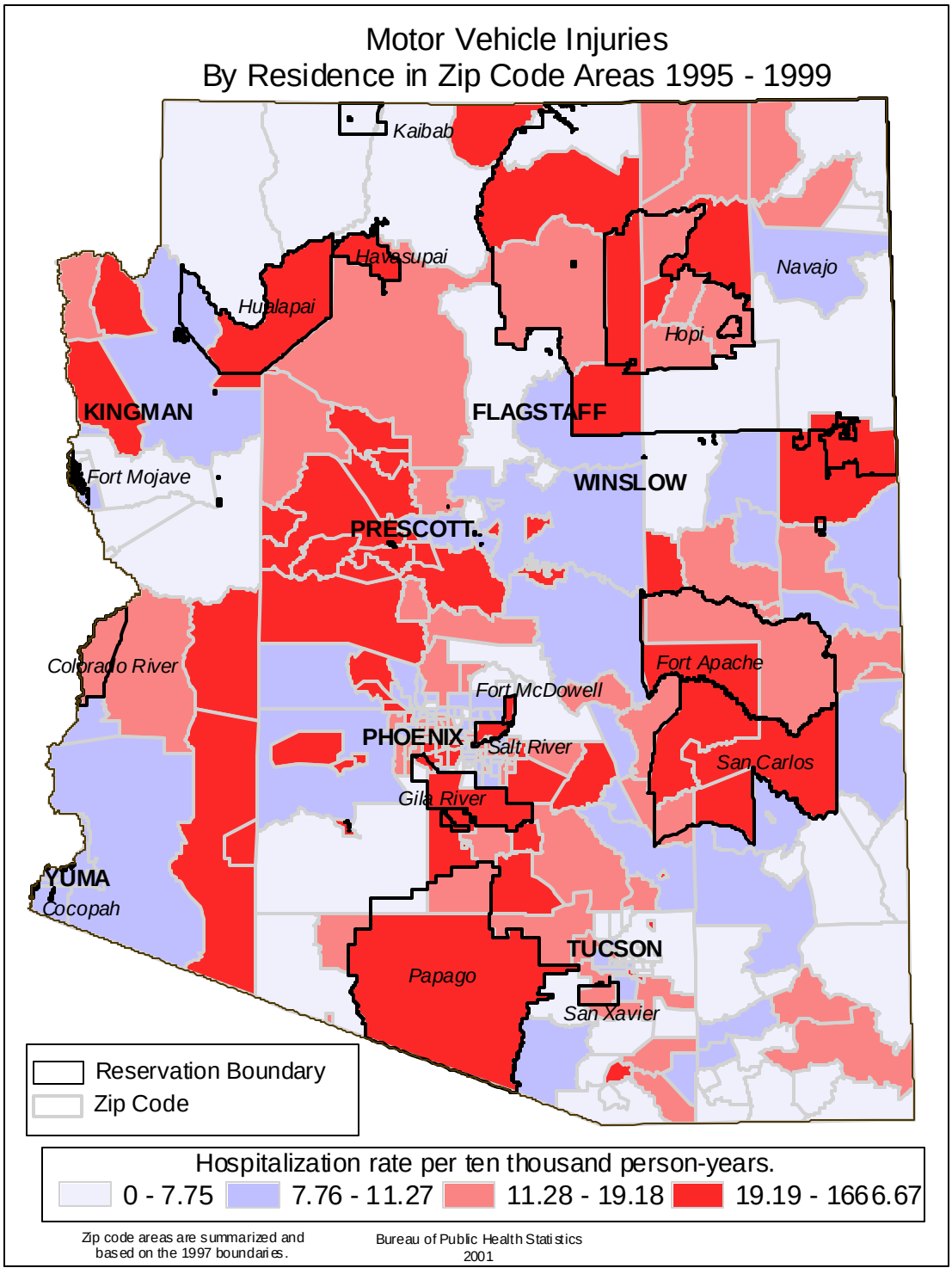
Map 2. Overlay of Indian reservation boundaries onto zip code boundaries.



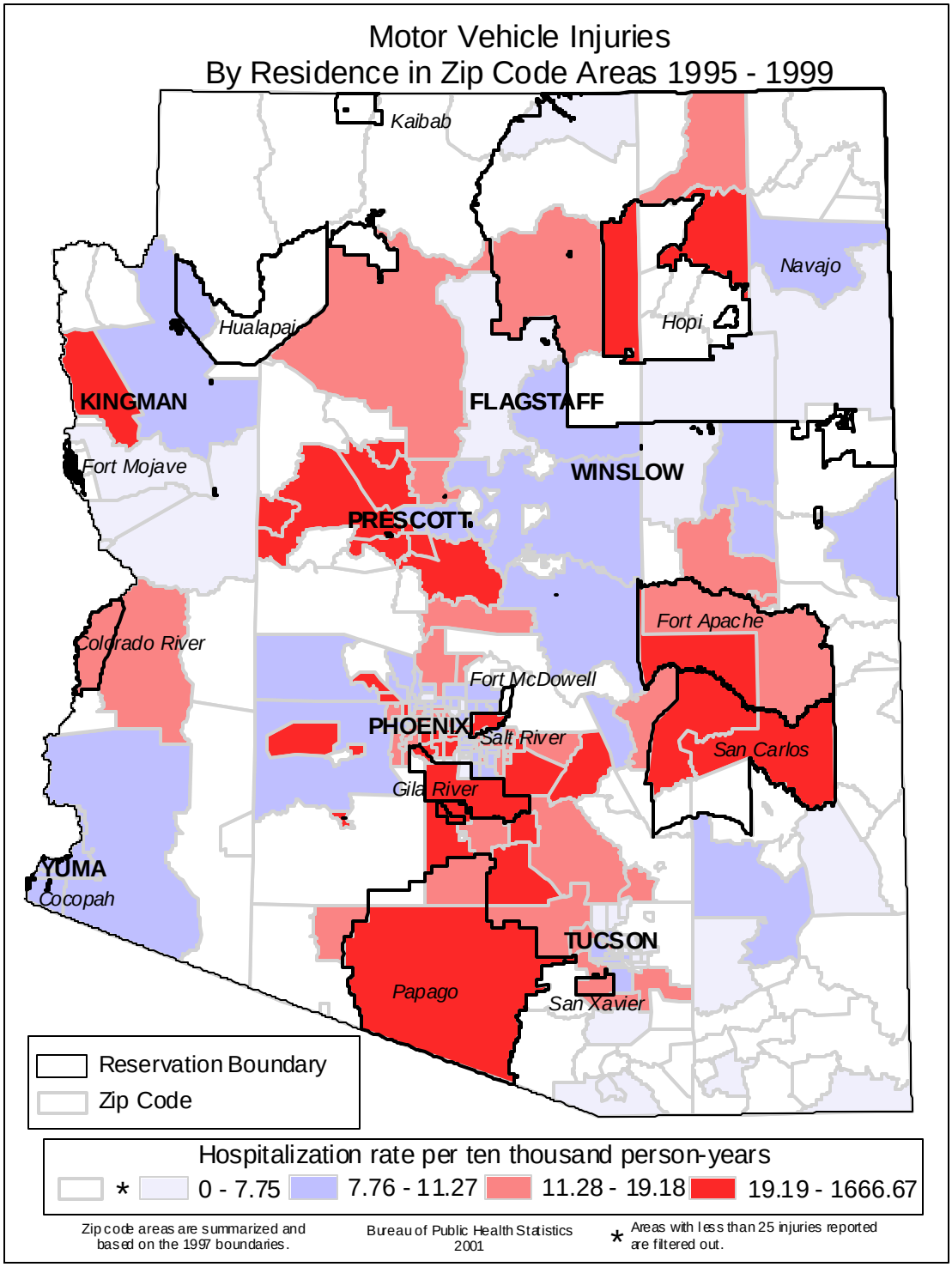
Map 3. Count of persons hospitalized for motor vehicle crash. The numbers within the zip code boudaries refer to the sum of hospitalizations during 1995-1999 for persons living in the given zip code. City names and Reservation boundaries are shown for orientation only.



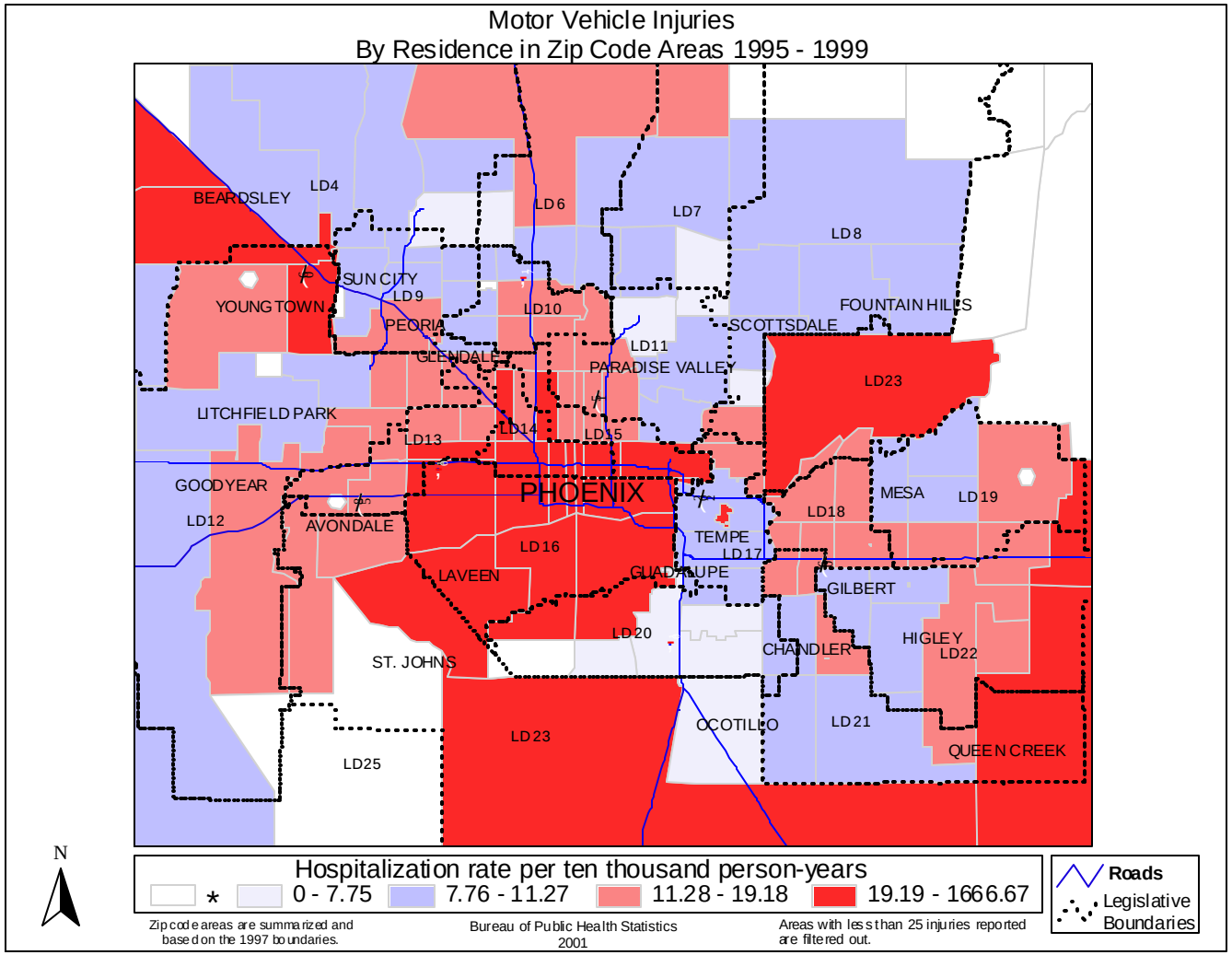
Map 4. Quantile of the hospitalization rate per 10,000 residents living within 303 zip code boundaries, showing zip code areas regardless of the number of incidents upon which the rate is based. City names and Reservation names are shown only for purposes of orienting the reader.



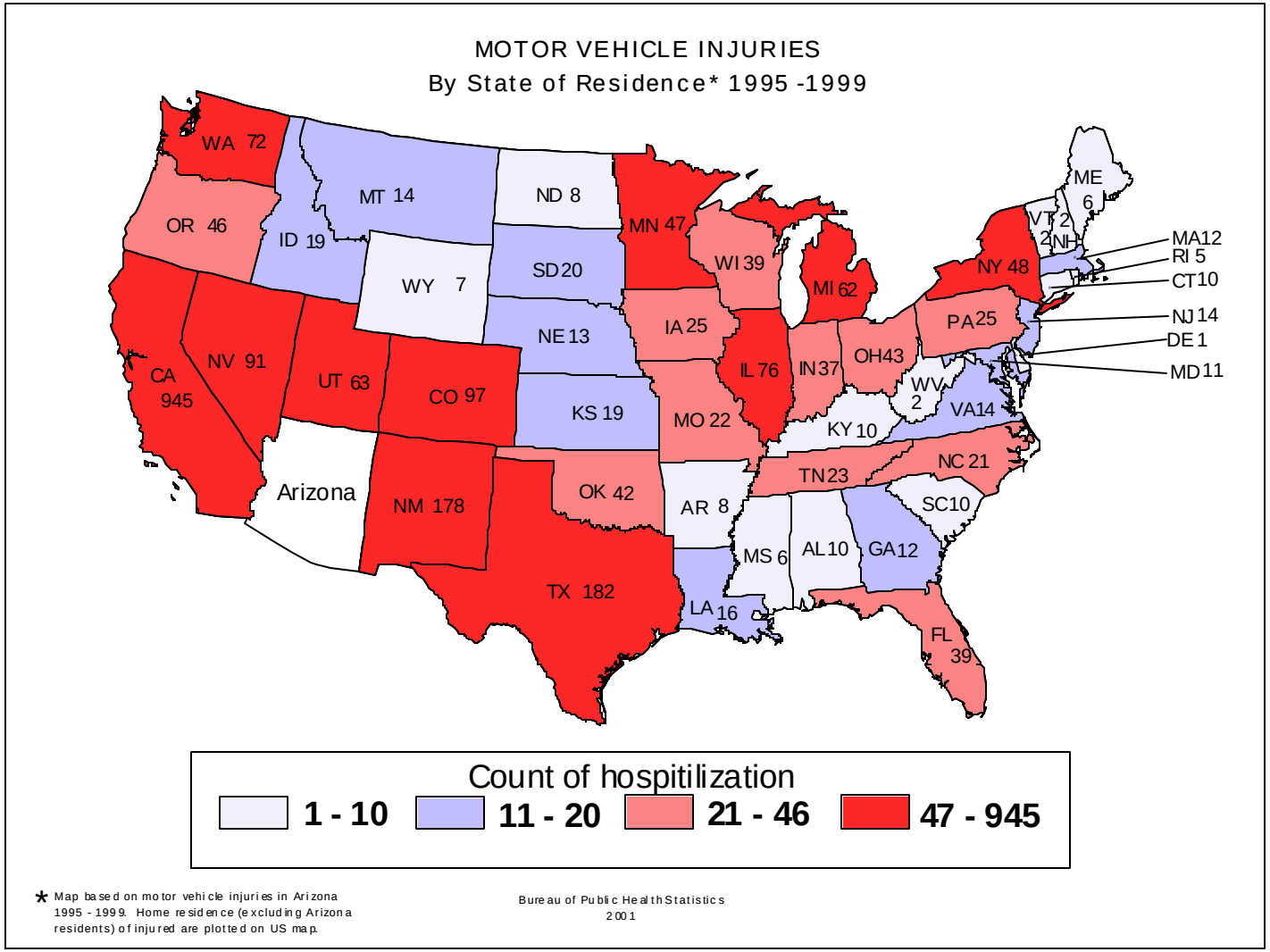
Map 5. Quantile of hospitalization rate per 10,000 residents. Zip codes with fewer than 25 hospitalizations have been suppressed because we consider their rates to be statistically unreliable. City names and Reservation names are shown merely to orient readers to these geo-political landmards.



Map 6. Quantile of hospitalization rate (per 10,000 residents) in Maricopa county zip codes with 25 or more hospital discharges for motor vehicle crash. Legislative district boundaries are shown.



Map 7. Count of persons residing in other states who were hospitalized in Arizona because of a motor vehicle crash.



Appendix Table 1

Hospitalizations for Motor Vehicle-Related Injuries By Residence in Zip Code Area, 1995-1999

Zip_Area	Merge	Sum Of Population In 1997	Hospitalization Count	Rate Per 10,000 Person-Yrs
00197	y	0	0	0.000
00199	y	0	4	0.000
00200	y	0	0	0.000
00201	y	0	0	0.000
85003	n	9930	144	29.003
85004	n	4745	194	81.770
85006	n	29456	356	24.172
85007	n	13826	292	42.239
85008	n	49536	488	19.703
85009	n	47088	558	23.700
85012	n	5874	53	18.046
85013	n	19735	187	18.951
85014	n	28062	239	17.034
85015	n	37539	364	19.393
85016	n	34273	235	13.713
85017	n	33441	315	18.839
85018	n	39392	212	10.764
85019	n	20721	232	22.393
85020	n	34643	258	14.895
85021	n	35336	242	13.697
85022	n	43080	231	10.724
85023	n	57959	314	10.835
85024	n	28968	115	7.940
85027	n	35711	225	12.601
85028	n	20903	77	7.367
85029	n	42788	276	12.901
85031	n	24930	226	18.131
85032	n	68517	386	11.267
85033	n	47215	402	17.028
85034	n	7020	175	49.858
85035	n	36723	378	20.587
85037	n	25457	198	15.556
85040	n	51622	581	22.510
85041	n	28497	356	24.985
85043	n	8170	127	31.089
85044	n	53700	160	5.959
85045	n	2071	10	9.657
85048	n	17299	34	3.931
85051	n	39451	272	13.789
85201	n	48915	359	14.679
85202	n	40466	238	11.763
85203	n	35959	221	12.292
85204	n	58199	380	13.059
85205	n	40483	214	10.572
85206	n	22569	145	12.849
85207	n	19868	148	14.898
85208	n	33107	205	12.384
85210	n	37763	252	13.346
85213	n	34846	160	9.183
85214	n	3378	0	0.000
85215	n	13237	74	11.181
85219	y	19994	137	13.704
85220	n	20948	211	20.145
85222	y	37446	251	13.406
85224	n	65694	312	9.499
85225	n	28740	165	11.482
85226	n	38975	103	5.285
85228	n	10234	103	20.129
85231	y	7317	109	29.794
85232	y	11097	64	11.535
85233	n	27928	112	8.021
85234	n	29144	125	8.578
85236	n	6180	59	19.094
85237	n	2852	13	9.116
85239	n	5617	73	25.993
85242	y	8152	107	26.251
85244	n	5202	0	0.000
85247	y	6851	230	67.143
85248	n	20782	83	7.988
85249	n	8950	44	9.832
85250	n	18586	72	7.748
85251	n	36307	263	14.488
85253	n	16911	88	10.407
85254	n	47510	150	6.314

Zip_Area	Merge	Sum Of Population In 1997	Hospitalization Count	Rate Per 10,000 Person-Yrs
85255	n	9500	49	10.316
85256	n	3517	70	39.807
85257	n	29420	214	14.548
85258	n	25743	107	8.313
85259	n	17852	71	7.954
85260	n	31559	148	9.379
85262	n	3819	13	6.808
85263	n	1076	3	5.576
85264	n	547	9	32.907
85268	n	15380	81	10.533
85272	n	1898	22	23.182
85273	n	3080	39	25.325
85278	n	1536	1	1.302
85281	n	43619	211	9.675
85282	n	52247	282	10.795
85283	n	43869	205	9.346
85284	n	16800	49	5.833
85287	n	3724	129	69.280
85290	n	120	0	0.000
85292	y	3677	24	13.054
85296	n	10749	54	10.047
85299	n	4510	0	0.000
85301	n	56160	482	17.165
85302	n	36054	166	9.208
85303	n	18389	166	18.054
85304	n	27828	117	8.409
85305	n	4468	30	13.429
85306	n	24388	98	8.037
85307	n	7486	34	9.084
85308	n	46674	180	7.713
85309	n	4526	9	3.977
85310	n	15458	70	9.057
85313	n	7	3	857.143
85321	n	6911	43	12.444
85322	n	574	11	38.328
85323	n	22004	211	19.178
85324	n	2905	25	17.212
85326	n	15783	81	10.264
85328	n	184	1	10.870
85329	n	4183	1	0.478
85331	n	16255	106	13.042
85332	n	806	9	22.333
85333	n	696	13	37.356
85335	n	5492	58	21.122
85337	n	2324	29	24.957
85338	n	7655	53	13.847
85339	n	7328	121	33.024
85340	n	8982	36	8.016
85341	n	132	1	15.152
85342	n	1153	13	22.550
85343	n	329	67	407.295
85344	y	12944	81	12.515
85345	n	42750	263	12.304
85347	n	719	10	27.816
85348	y	1524	23	30.184
85350	y	26933	145	10.767
85351	n	36385	186	10.224
85353	n	6633	50	15.076
85354	y	2607	35	26.851
85355	n	3789	28	14.780
85356	y	5180	27	10.425
85361	n	3185	47	29.513
85362	n	950	13	27.368
85363	n	2661	13	9.771
85364	n	64493	343	10.637
85365	n	21261	96	9.031
85367	n	8219	44	10.707
85373	n	11609	53	9.131
85374	n	6325	73	23.083
85375	n	26323	108	8.206
85377	n	4946	0	0.000
85380	n	2156	1	0.928
85381	n	17103	78	9.121
85382	n	18964	82	8.648
85390	y	10988	46	8.373
85501	y	12896	73	11.321
85530	n	1175	18	30.638
85533	n	2377	12	10.097
85534	n	2561	9	7.029
85535	n	97	1	20.619
85539	y	6901	35	10.143
85540	n	4349	9	4.139
85541	y	18282	85	9.299
85542	n	1077	31	57.567

Zip_Area	Merge	Sum Of Population In 1997	Hospitalization Count	Rate Per 10,000 Person-Yrs
85543	y	2997	16	10.677
85544	n	1834	22	23.991
85545	n	976	8	16.393
85546	y	14847	53	7.139
85550	n	4617	78	33.788
85552	n	5795	18	6.212
85602	y	9149	33	7.214
85603	y	9749	23	4.718
85606	y	942	1	2.123
85607	y	20223	70	6.923
85610	n	1370	8	11.679
85611	n	357	2	11.204
85613	n	8141	14	3.439
85614	y	22960	57	4.965
85615	n	4209	10	4.752
85616	n	3870	20	10.336
85617	n	2710	7	5.166
85618	n	1906	19	19.937
85619	n	34	1	58.824
85621	n	18992	68	7.161
85623	n	4225	26	12.308
85624	n	1110	9	16.216
85625	n	1952	13	13.320
85629	n	5465	36	13.175
85630	n	1771	8	9.034
85631	n	4715	20	8.484
85632	y	1237	3	4.850
85634	y	7566	131	34.629
85635	y	39524	55	2.783
85637	n	1006	7	13.917
85638	n	3016	6	3.979
85640	n	757	9	23.778
85641	n	4023	15	7.457
85643	y	7953	36	9.053
85645	y	2760	3	2.174
85648	y	11466	35	6.105
85653	y	10952	84	15.340
85701	n	5554	52	18.725
85704	n	24564	114	9.282
85705	n	54200	358	13.210
85706	n	60143	311	10.342
85707	n	6	5	1666.667
85708	n	6062	10	3.299
85709	n	172	3	34.884
85710	n	55915	203	7.261
85711	n	42777	166	7.761
85712	n	32507	118	7.260
85713	n	45850	257	11.210
85714	n	15458	88	11.386
85715	n	16018	62	7.741
85716	n	32518	170	10.456
85718	n	26214	79	6.027
85719	n	41873	157	7.499
85721	n	13	5	769.231
85730	n	36986	117	6.327
85735	n	6031	17	5.638
85736	n	1520	7	9.211
85737	n	20871	67	6.420
85738	n	801	0	0.000
85739	n	8940	32	7.159
85741	n	30329	144	9.496
85742	n	19272	72	7.472
85743	n	10697	96	17.949
85745	n	27858	134	9.620
85746	n	38540	288	14.946
85747	y	6025	35	11.618
85748	n	14608	31	4.244
85749	n	16770	49	5.844
85750	n	24516	58	4.732
85901	y	25517	239	18.733
85920	n	524	4	15.267
85922	n	50	0	0.000
85924	y	1446	10	13.831
85925	y	1762	14	15.891
85928	y	1223	16	26.165
85929	n	4594	33	14.367
85935	n	2505	15	11.976
85936	n	5750	31	10.783
85937	y	10013	49	9.787
85938	n	5014	20	7.978
86001	y	43626	163	7.473
86004	n	28708	117	8.151
86021	n	4391	1	0.455
86022	n	1751	0	0.000

Zip_Area	Merge	Sum Of Population In 1997	Hospitalization Count	Rate Per 10,000 Person-Yrs
86024	n	219	16	146.119
86025	y	8338	41	9.834
86030	n	1176	7	11.905
86033	n	5891	42	14.259
86034	n	3214	20	12.446
86035	n	368	19	103.261
86036	n	462	5	21.645
86038	n	72	0	0.000
86039	n	1767	16	18.110
86040	n	12854	43	6.691
86042	n	1630	10	12.270
86043	n	1253	14	22.346
86044	n	2850	35	24.561
86045	n	9994	81	16.210
86046	y	8845	51	11.532
86047	y	21980	76	6.915
86053	n	1945	19	19.537
86054	n	1602	15	18.727
86301	y	28176	371	26.334
86303	n	13274	132	19.889
86314	y	22558	279	24.736
86320	n	1171	13	22.203
86321	n	2387	39	32.677
86322	n	8558	45	10.516
86323	n	9500	155	32.632
86324	y	3988	31	15.547
86325	n	3136	12	7.653
86326	n	17295	74	8.557
86327	y	6948	85	24.467
86332	y	1097	23	41.933
86333	n	3676	54	29.380
86334	n	718	26	72.423
86335	y	2018	23	22.795
86336	y	12722	50	7.860
86337	n	728	6	16.484
86343	n	165	1	12.121
86351	y	4334	20	9.229
86401	y	35212	182	10.337
86403	y	18649	58	6.220
86404	n	9883	27	5.464
86406	y	14285	48	6.720
86413	n	4903	56	22.843

Zip_Area	Merge	Sum Of Population In 1997	Hospitalization Count	Rate Per 10,000 Person-Yrs
86426	y	6301	15	4.761
86429	y	4358	19	8.720
86432	n	716	0	0.000
86434	n	1092	15	27.473
86435	n	378	4	21.164
86436	n	1142	5	8.757
86440	n	5025	13	5.174
86441	n	722	6	16.620
86442	y	23522	77	6.547
86444	y	341	6	35.191
86502	n	1317	15	22.779
86503	y	12186	61	10.011
86505	y	31185	68	4.361
86507	n	2005	6	5.985
86510	n	2499	33	26.411
86514	n	3174	1	0.630
86535	n	1358	10	14.728
86538	n	1670	11	13.174
86556	n	2748	3	2.183

ENDNOTES

[1] Mrela, C. *Arizona Health and Vital Statistics, 1999.* Arizona Department of Health Services.
[2] CDC. State Injury Profile for Arizona, 1995-1997. Centers for Disease Control, Atlanta, GA. 1997.
[3] Arizona Dept of Transportation. *Motor Vehicle Crash Facts for Arizona, 1999.* Motor Vehicle Crash Statistics Unit., Traffic Records Section. Table 1-3, page 4 of the ADOT Profile presents the historic trends of Arizona and US motor vehicle rates.
[4] The section heading in the ICD-9-CM for this group is Motor Vehicle Traffic Accidents (E810-E819). The specific conditions included within this group are:
E810 Motor vehicle traffic accident involving collision with train
E811 Motor vehicle traffic accident involving re-entrant collision with another vehicle
E812 Other motor vehicle traffic accident involving collision with motor vehicle
E813 Motor vehicle traffic accident involving collision with other vehicle
E814 Motor vehicle traffic accident involving collision with pedestrian
E815 Other motor vehicle traffic accident involving collision on the highway
E816 Motor vehicle traffic accident due to loss of control, without collision on the highway
E817 Noncollision motor vehicle traffic accident while boarding or alighting
E818 Other noncollision motor vehicle traffic accident
E819 Motor vehicle traffic accident of unspecified nature